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(71) Applicant: ERICSSON INC. [US/US]; 7001 Development Drive, P.O. Box 13969, Research Triangle Park, NC 27709 (US).

(72) Inventors: NAIDU, Arun; 9628 Berryville Court, Raleigh, NC 27613 (US). MORELEN, Steven; 100 Hobblebrook Court, Cary, NC 27511 (US).

(74) Agents: GRUDZIECKI, Ronald, L. et al.; Burns, Doane, Swecker & Mathis, L.L.P., P.O. Box 1404, Alexandria, VA 22313-1404 (US).

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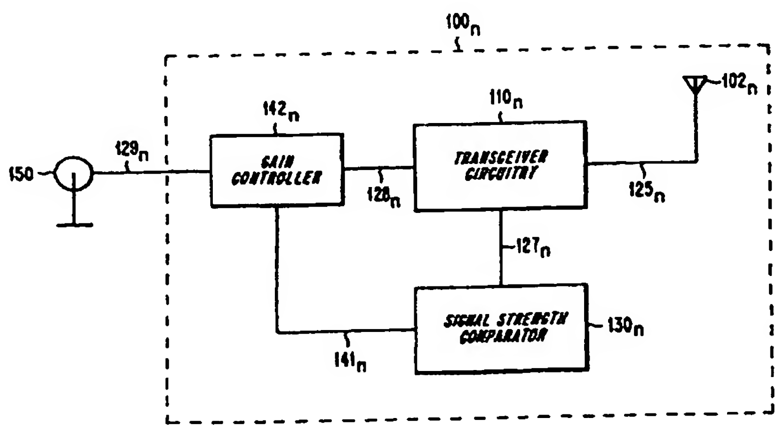
(54) Title: SYSTEM AND METHOD FOR CONTROLLING THE LEVEL OF SIGNALS OUTPUT TO TRANSMISSION MEDIA IN A DISTRIBUTED ANTENNA NETWORK



(57) Abstract

A system and method are provided for controlling the gain of signals transported over transmission media in a distributed antenna network. The system includes a plurality of remote antenna units where each remote antenna unit includes a signal level comparator for comparing the level of the signals received by the respective antenna unit with a predetermined reference level, and a gain controller for reducing the gain of the remote antenna unit when the signal level comparator determines that the level of the received signal exceeds said predetermined reference level. The system may accommodate TDMA systems when a gain controller is used that is fast enough to respond within the time slots of the received signals. As a result, the signal levels output from the remote antenna units are prevented from exceeding a maximum signal level.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be more fully understood by reading this description in conjunction with the accompanying drawings, which are given by way of illustration only, and thus are not limitative of the present invention, wherein:

Figure 1 illustrates a conventional distributed antenna network;

Figure 2 illustrates a block diagram of a known CATV infrastructure which supports PCS;

Figures 3a and 3b are block diagrams showing embodiments of the system for controlling the gain in a distributed antenna network according to the present invention; and

Figure 4 is a block diagram showing a system infrastructure in which a gain control system according to an embodiment of the present invention is implemented.

DETAILED DESCRIPTION

This invention is directed to a system and method which controls the gain in a plurality of remote antenna units of a distributed antenna network. Often in distributed antenna networks, signals covering a wide range of amplitudes are attempted to be transported from the remote antenna units across transmission media which are not capable of handling such a wide range of amplitudes. In particular, when a strong signal is received by a remote antenna unit (for instance, when a mobile station is directly under a remote antenna unit), it is desirable to reduce the gain of the remote antenna unit so that the strong signal does not saturate the system. Accordingly, the system and method of the present invention reduce the level of signals produced by remote antenna units when the received signal level exceeds a predetermined reference level.

Figure 3(a) illustrates one example of a system that is used in each remote antenna unit for controlling the gain in a distributed antenna network according to the present invention. In this system, a plurality of remote antenna units 100_n are connected to a network output 150 but only a representative remote antenna

unit 100_n is shown in Figure 3(a). An antenna 102_n provides an RF input signal 125_n to transceiver circuitry 110_n in this system. The transceiver circuitry 110_n is connected to a signal strength comparator 130_n which compares a predetermined reference level with a signal 127_n which is output from the transceiver circuitry 110_n and corresponds to the signal 125_n received by the antenna 102_n. The signal strength processor 130_n outputs an error signal 141_n when the signal 127_n is determined to exceed the predetermined reference level. A gain controller 142_n receives the error signal 141_n and a signal 128_n which is output from the transceiver circuitry 110_n and corresponds to the signal 125_n received by the antenna 102_n. The gain controller 142_n controls the gain of the remote antenna unit 100_n based on the error signal 141_n such that the output signal 129_n has the proper level.

The signal strength comparator 130_n determines whether the level of the signal 129_n exceeds the maximum level permitted by the transmission media. Therefore, the predetermined reference level is selected to correspond to the maximum permitted level. Typically, this predetermined reference level is set in each remote antenna unit 100_n upon installation to correspond with maximum signal level capable of being transmitted over the transmission media. However, this predetermined reference level may be later modified after installation for use with different transmission media. The signal strength comparator 130_n determines whether the signal 127_n indicates that the signal 129_n exceeds the predetermined reference level; if so, the error signal 141_n is generated in proportion to the difference between the signal 127_n and the predetermined reference level. The error signal 141_n is input to the gain controller 142_n and the level of signal 128_n is reduced in proportion to the level of the error signal 141_n. As a result, the signal 129_n output to the network across the transmission media is prevented from saturating the system.

Figure 3(b) illustrates in more detail components that may be preferably used in the block diagram of Figure 3(a). The transceiver circuitry 110_n includes a low noise amplifier 112_n connected to the antenna 102_n for amplifying RF

signals 125_n generated by the antenna 102_n. The amplified signal is further processed by a preselecting filter 114_n, a mixer 116_n connected to a first local oscillator 118_n, and an intermediate frequency filter 120_n. A standard coupler 122_n sends a portion of this processed signal 127_n to the signal strength comparator 130_n and a portion to a mixer 124_n. The mixer 124_n is connected to a second local oscillator 126_n and outputs signal 128_n to the gain controller 142_n.

The signal strength comparator 130_n includes a diode 132_n for converting the signal 127_n to a DC level for comparison with the predetermined reference level. A reference level generator 134_n is used for generating the predetermined reference level. The reference level generator 134_n is set based on the transmission media as described above. A differential amplifier 136_n compares the output of the diode 132_n with the signal output by the reference level generator 134_n. The comparison output of the differential amplifier 136_n is further processed by a half wave rectifier 137_n and a scale and offset amplifier 138_n for outputting the error signal 141_n. The half wave rectifier 137_n and the scale and offset amplifier 138_n process the signal output from the differential amplifier 136_n so that the gain controller 142_n may reduce the signal 129_n to a level below the maximum permitted output level of the transmission media. It will be appreciated that modifications and other circuitry may be used for generating the error signal 141_n which controls the gain controller 142_n.

The gain controller 142_n includes a variable gain amplifier 144_n. This variable gain amplifier 144_n controls the level of the signal 129_n in response to the error signal 141_n. By choosing the variable gain amplifier 144_n to be sufficiently fast, the present system may be used in TDMA applications. For example, an analog device AD603 integrated circuit may be used for the variable gain amplifier 144_n so that the gain of the amplifier responds to the error signal 141_n within the time slots of TDMA standards.

Figure 4 illustrates an example of a CATV system infrastructure that may advantageously utilize Applicants' system and method for equalizing delay. The infrastructure includes fiber nodes $200_1, \ldots 200_n$ which are connected to a CATV

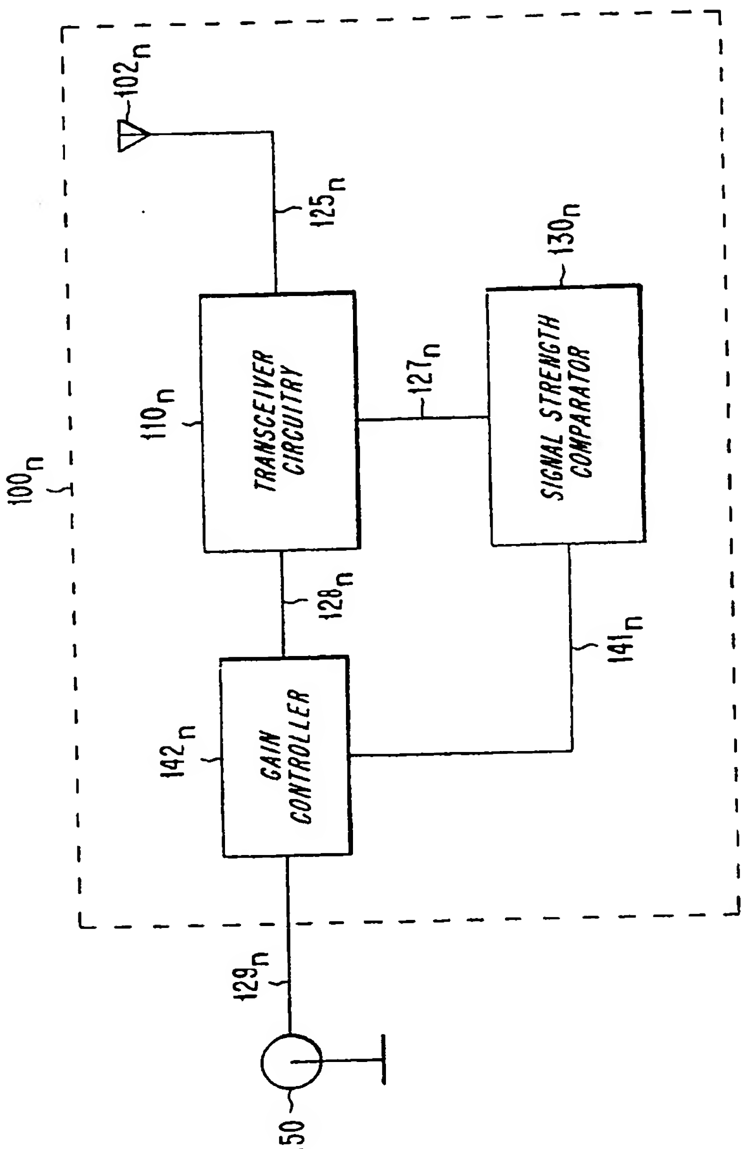

100_n
102_n
125_n
110_n
TRANSCEIVER CIRCUITRY
127_n
130_n
SIGNAL STRENGTH COMPARATOR
128_n
141_n
142_n
GAIN CONTROLLER
129_n
150

Fig. 3(a)

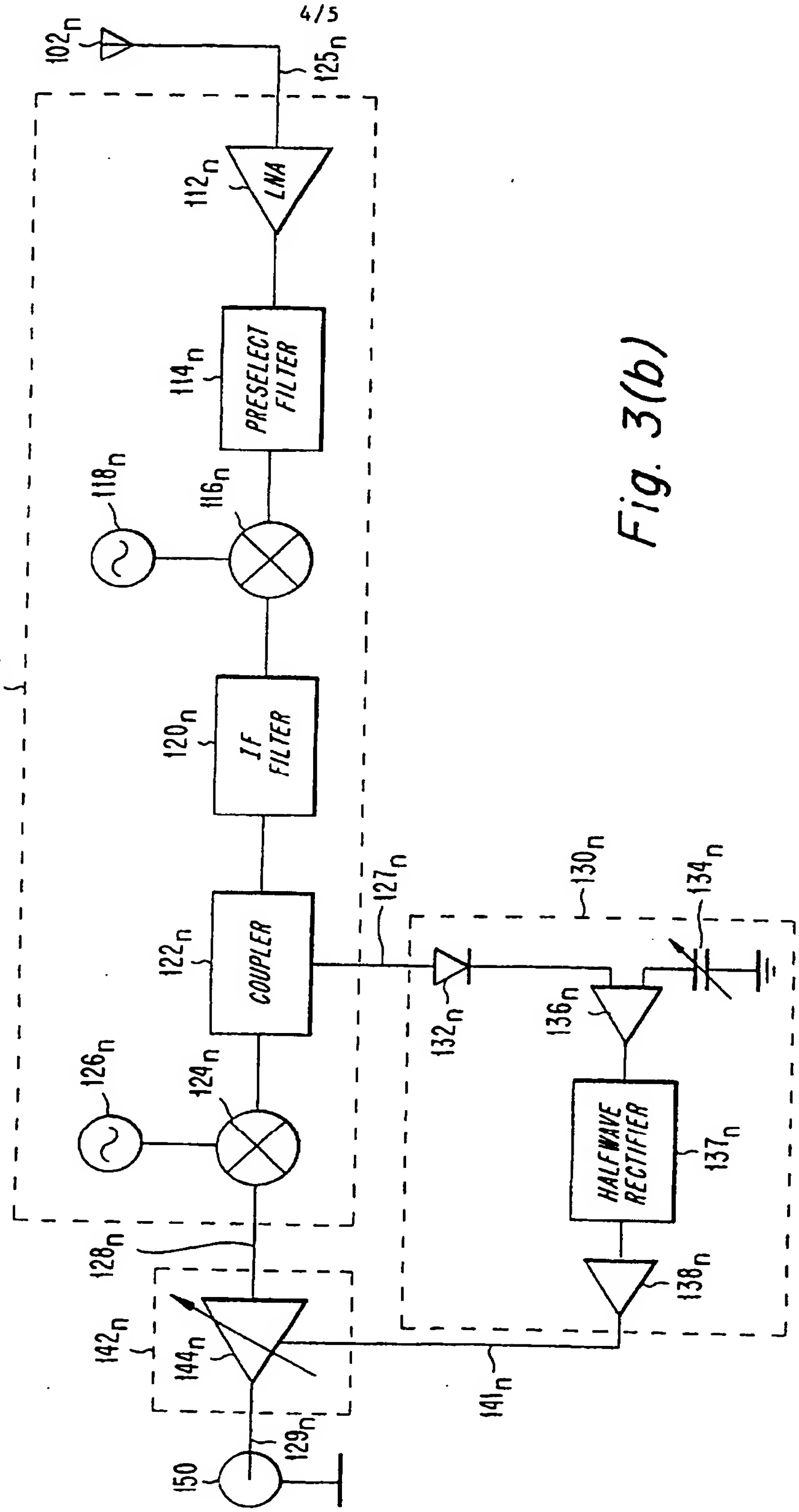

102n
125n
112n
LNA
114n
PRESELECT FILTER
118n
116n
110n
120n
IF FILTER
122n
COUPLER
127n
130n
134n
132n
136n
126n
124n
HALFWAVE RECTIFIER
137n
128n
138n
142n
144n
141n
129n
150

Fig. 3(b)